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Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
OGDEN, UTAH 84401

USDA Forest Service
Research Note INT-159

April 1972

RESPONSES IN A WESTERN WHITE PINE STAND TO COMMERCIAL THINNING METHODS

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ABSTRACT

*Effects of crown and selection thinning at two levels (20 percent and 35 percent volume removed) and of no thinning were compared in an 87-year-old mixed conifer stand dominated by western white pine (*Pinus monticola *Dougl.) and grand fir* [Abies grandis *(Dougl.) Lindl.]. The 35-percent crown thinning produced the best diameter growth response and resulted in least mortality during the 10 years following treatment. Net annual volume growth per acre was highest on the control plots (837 board feet), but was nearly as high for light-crown thinning (776 board feet). Light selection thinning was almost as effective as the crown thinnings, but 35 percent selection thinning resulted in excessive mortality and reduced net volume growth.*

Stands of the western white pine (*Pinus monticola* Dougl.) type tend to be overstocked, and the effect of overstocking on timber yields has not been fully recognized until recent years. It has been estimated that natural, well-stocked western white pine stands at rotation age of 120 years have only 43 percent of the board-foot volume they could have if stocking were controlled through regular thinnings (Wikstrom and Wellner 1961).

Past experience has shown that small sawlog stands have suffered heavy mortality due to overstocking. Watt (1960) found that mortality nullified 10 to 44 percent of the gross board-foot volume growth in stands 70 to 100 years of age. The forest manager's problem, then, is to find a management system that will take advantage of the high productive capacity of western white pine sites without losing a large part of that production to mortality. The present study was begun in 1953 to explore the

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possibility that a commercial thinning at about 80 years of age might keep these stands in a thrifty, vigorous condition less susceptible to mortality agents.[2] Such thinning might also increase growth on residual trees and utilize anticipated mortality.

Since this experiment began, administrators of the National Forests in the Northern Rocky Mountains reexamined their management programs after finding that control efforts against the blister rust fungus (*Cronartium ribicola* J. C. Fisch.) on western white pine had failed. In the realignment of priorities, administrators decided to favor other species in planting, weeding, and thinning programs until an effective and economical method of controlling blister rust was found (Ketcham, Wellner, and Evans 1968). Although management of western white pine is no longer emphasized, results of this experiment are worthwhile:

1. The region still contains considerable acreage of small saw timber stands that contain white pine;

2. Managers will not abandon white pine permanently. USDA Forest Service's Northern Region is beginning to plant western white pines that are genetically resistant to blister rust. These resistant trees are the result of vigorous USDA Forest Service research programs that also include efforts to develop biological or chemical rust control treatments. Continuing research should reestablish western white pine as an important component of managed stands in this region;

3. The stands on the study plots include other species that have benefited from the treatments.

STAND DESCRIPTION

The test was located on the Clearwater National Forest in northern Idaho in an even-aged stand dominated by western white pine. Study sites represented two habitat types described by Daubenmire and Daubenmire (1968): the *Thuja plicata/Pachistima myrsinites* habitat type, on north-facing slopes; and the *Abies grandis/Pachistima myrsinites* habitat type on all other sites. Grand fir [*Abies grandis* (Dougl.) Lindl.] was the chief associate of western white pine, but western larch (*Larix occidentalis* Nutt.), Douglas-fir [*Pseudotsuga menziesii* var. *glauca* Beissn.) Franco], western redcedar (*Thuja plicata* Donn), lodgepole pine (*Pinus contorta* Dougl.), Engelmann spruce (*Picea engelmannii* Parry), and subalpine fir [*Abies lasiocarpa* var. *lasiocarpa* (Hook.) Nutt.] were also present.

The topography was gently rolling and plots were on all aspects, primarily on north- or east-facing slopes. Soils were deep, sandy loams underlain by basalt. Elevation was approximately 3,200 feet. In 1953 the stand age was 87 years. Based on the western white pine site index, site quality was excellent, varying between blocks from 77 to 86 (the average site was 79 feet at 50 years), according to Haig (1932). In comparison with normal yield-table values for stands of similar age and site quality, stocking in terms of basal area was down about 10 percent: in terms of cubic foot volume, it was almost the same; in terms of board-foot volume, it was about 6 percent higher (fig. 1).

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[2]This study was made in cooperation with the Clearwater National Forest personnel who administered the timber sale and protected the experimental area during the period of the study. C. A. Wellner assisted in designing and establishing the study; R. J. Boyd and G. H. Deitschman assisted in remeasurements of the plots and compilation of the data; all three are associated with the Intermountain Station.

Figure 1.--Before thinning, this 87-year-old stand was well-stocked, averaging about 230 square feet of basal area and 59,000 board feet per acre.

METHODS

The Clearwater National Forest sold timber from this experimental thinning according to regular commercial timber sale procedures. Logs were skidded by horse to minimize damage to residual trees. Logging slash was piled by hand and burned. The study was laid out in a randomized block design that called for five treatments and three blocks, or replications. Initially, each of the 15 plots was 1 acre in size, but one control plot was later reduced to 1/2 acre because of accidental logging disturbance. Treatments were randomly assigned to the plots in each block as follows:

1. *Light crown thinning.*--The main objective was to release the crowns of the best dominant and codominant trees by removing competing trees in the same crown classes. In addition, trees of poor vigor in all crown classes were cut (fig. 2). The intended cut was about 25 percent of the board-foot volume; the actual cut averaged 17 percent.

Figure 2.--Plot 508 as it appeared after light crown thinning in 1953. Crown thinnings gave increased growing space to the largest, most vigorous trees.

Figure 3.--Plot 506 after light selection thinning which harvested the largest stems and released well-formed codominant and intermediate trees. Compare with figure 2.

2. *Moderate crown thinning*.--This type of thinning is similar to light crown thinning only heavier. The intended cut was 40 percent of the board-foot volume; the actual cut averaged 35 percent.

3. *Light selection thinning*.--In contrast to the crown thinning treatments, the selection thinnings removed trees of largest diameters until the prescribed volume was cut (fig. 3). The intent was to release trees in the intermediate and codominant crown classes for future crop trees. A selected crop tree generally had a straight stem and few branches on the lower bole. It was hoped that release would promote rapid growth of quality timber. Light thinning was intended to remove about 25 percent of the board-foot volume; the actual cut averaged 21 percent.

4. *Moderate selection thinning*.--This type of thinning is similar to light-selection thinning only heavier. The intended cut was 40 percent of the board-foot volume; the actual cut averaged 34 percent.

5. *Unthinned control*.

All trees 5.6 inches d.b.h. and larger were included in the stand. Measurements of d.b.h., description of crown class, and crown condition were recorded for each tree. Sufficient heights were measured to construct a local volume table for each species. The effects of thinning treatments on stand parameters are shown in table 1. Trees were recorded according to cause of death when it could be determined. Net volume increments used were the differences between living tree volumes for the years of measurement. Gross increment was determined by adding periodic mortality to net increment. Diameter growth analyses by species and treatment were based on all residual trees in the stand. Analyses of variance and multiple-range tests were used to test treatment differences.

The plots were remeasured in 1958, 1963, and 1968. However, during the last 5 years, heavy mortality, mostly the result of western white pine blister rust and mountain pine beetles (*Dendroctonus ponderosae* Hopkins), masked the effects of thinning treatments on stand growth. Therefore, growth was analyzed for only 10 years after thinning

Table 1.--*Average stand conditions per acre before and after the 1953 thinning*

Thinning treatment	Trees[a]		Basal area		Cubic volume[b]		Sawlog volume[c]		Av. diameter	
	Before	After	Before	After	Before	After	Before	After	Before	After
	Number		*Square feet*		*M cu. ft.*		*M bd. ft.*		*Inches*	
Light crown	199	156	237	192	11.3	9.2	58.1	48.0	14.8	15.0
Moderate crown	183	106	214	135	10.2	6.5	52.4	33.9	14.7	15.3
Light selection	167	142	216	175	10.3	8.3	53.9	42.6	15.4	15.0
Moderate selection	204	160	226	158	10.7	7.3	54.2	35.7	14.3	13.4
Control	208	208	241	241	11.5	11.5	59.4	59.4	14.5	14.5

[a]Number of trees 5.6 inches d.b.h. and larger.

[b]Cubic feet of total stem, including top and stump, of trees 5.6 inches d.b.h. and larger.

[c]Board feet, Scribner rule, to a 6-inch top (d.i.b.), of trees 7.6 inches d.b.h. and larger.

RESULTS

Diameter Growth

The effect of thinning treatments on diameter growth of residual western white pine and grand fir trees was significant at the 5 percent level in an analysis of variance. Statistical differences between treatments as determined by multiple range tests are shown in figure 4. Grand fir responded better than western white pine to all four treatments. Grand fir growth improvement, over comparable control plots, ranged from 34 percent for light crown thinning to 63 percent for moderate crown thinning; however, western white pine in thinned plots grew only 11 to 35 percent faster than in the control plots.

Volume Growth and Mortality

Net annual gains in merchantable volume ranged from 492 board feet per acre on moderate selection plots to 837 board feet on control plots. The widest growth differences were statistically significant (fig. 5). Cubic volume increases ranged from 64 to 117 cubic feet per acre per year and treatments showed the same ranking as for board feet. In both cases, volume growth was more influenced by residual volume after thinning than by the thinning method.

However, volume losses due to mortality were related to the method of thinning (fig. 5). Over the 10-year period that followed crown thinning less mortality occurred among residual trees than among trees in the control plots. However, selectively-thinned plots actually showed an increased mortality rate. These results are logical when one considers the types of trees favored by the two thinning treatments. Crown thinnings released the strongest, most vigorous trees in the stand. Selection thinning, on the other hand, left the less vigorous codominants and intermediates in the residual stand. Such trees are smaller, less vigorous and more susceptible to mortality and to injury from wind, snow, and logging when the larger trees in stands are removed. Mortality was the major reason for the relatively poor net volume increment following selection thinning, particularly moderate selection thinning.

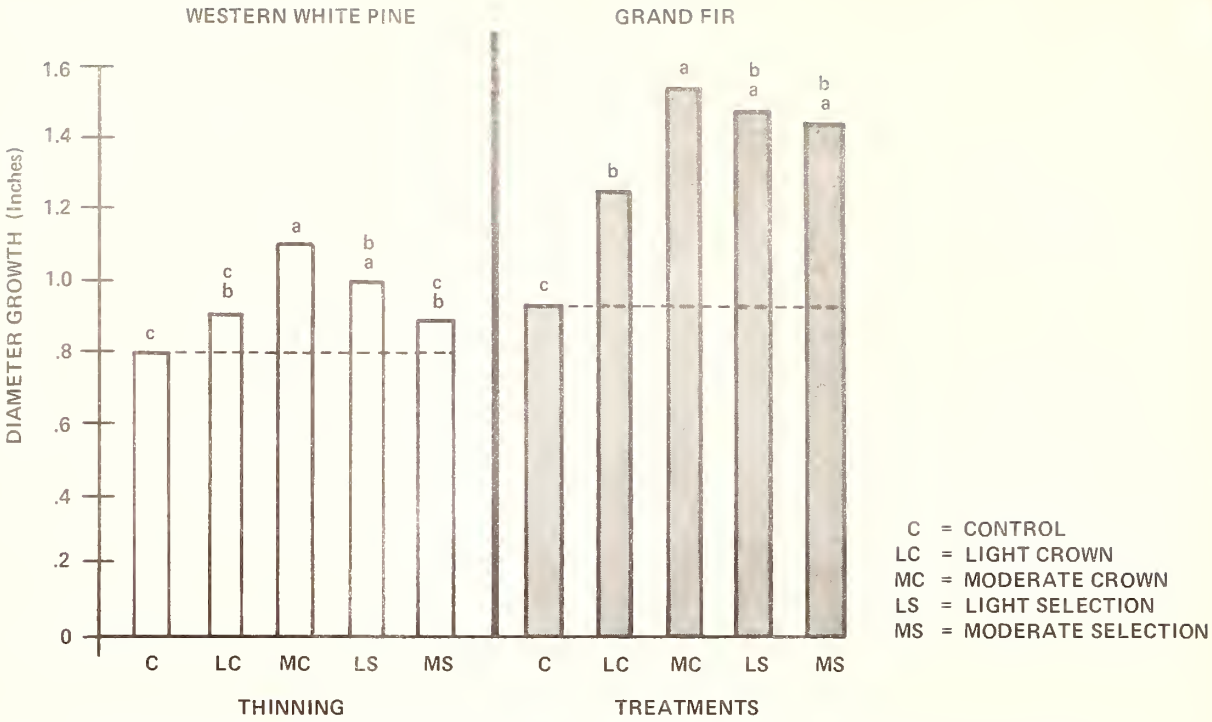

Figure 4.--Average 10-year-diameter growth per tree following thinning. (Growth means not indicated by the same letter are significantly different, P = 0.05.)

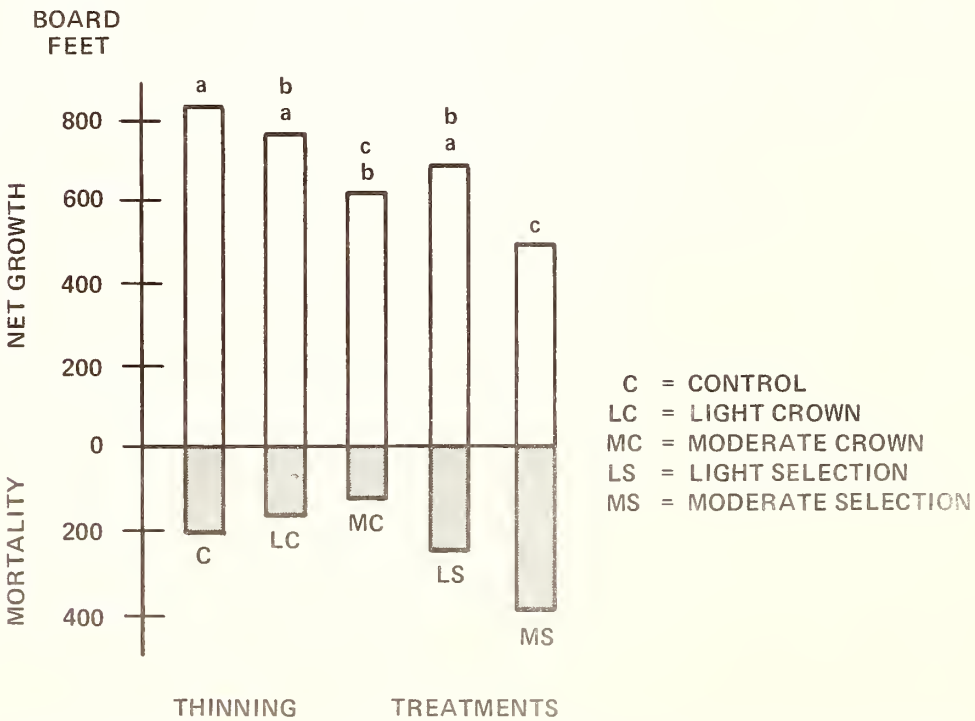

Figure 5.--Average annual board-foot growth and mortality per acre following thinning. (Increments not indicated by the same letter are significantly different, P = 0.05.)

DISCUSSION AND CONCLUSIONS

Commercial thinnings generally are intended to fulfill one or more of the following objectives: (1) to provide early monetary returns from the stand; (2) to reduce rotation length by improving the growth rate of residual trees; (3) to improve the quality of trees for the final harvest; (4) to utilize volume lost through mortality in unmanaged stands; and (5) to maintain near maximum volume growth per acre while fulfilling one or more of the other objectives.

How did the thinning treatments tested here compare in attaining the above objectives? No single treatment stands out as best for all purposes. However, moderate selection thinning was poorest for most purposes. Removal of so many large trees resulted in such heavy mortality and poor growth that this type of thinning is inadvisable under most circumstances.

Among the other three treatments, the choice should depend on the primary objective of thinning. If the main goal is to harvest anticipated mortality while maintaining near-maximum volume production, light crown thinning is the logical choice. If the primary objective is to increase diameter growth of residual trees, moderate crown thinning will give the best response. Light selection thinning permits harvesting the largest trees in a stand without significantly reducing the growth of residual trees. However, the trees left by selection thinning are smaller in average diameter; so they take longer to grow to a designated size.

Selection thinning might be appropriately applied to a mixed stand in which the dominant western white pines are infected with blister rust disease. Then, western white pines could be harvested while merchantable; this would release other species in the subdominant crown level for better growth.

Grand fir responded better than western white pine to all four treatments. However, the magnitude of the difference between species was greater for moderate selection thinning than for the other treatments. This difference reflects the response of trees in the lower crown classes to release by thinning. Grand fir is a more shade-tolerant species than western white pine. Tolerant trees in the lower crown classes retain relatively full crowns; therefore, they quickly utilize the increased growing space afforded them by thinning.

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